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PROCESSING METHOD FOR A SUBSTRATE

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to a processing method for a substrate, in particular, for conducting, under a condition of reduced pressure, an ashing process or the like upon the substrate, such as for example, a semiconductor wafer or a glass substrate.

2. DESCRIPTION OF PRIOR ART

For the purpose of effectively conducting processing such as an ashing process under a condition of reduced pressure, conventionally, an apparatus is known in which a load-lock chamber is provided in addition to a processing chamber. In the apparatus, while a substrate is processed in the processing chamber, another substrate to be processed next is loaded into the load-lock chamber to wait, and the load-lock chamber is depressurized to the pressure of the processing chamber. After the processing in the processing chamber is completed, the treated substrate in the processing chamber is taken out, and the untreated substrate waiting in the load-lock chamber is transferred into the processing chamber by means of a robot provided in the load-lock chamber.

In the aforementioned processing apparatus, since a general-purpose robot is provided in the load-lock chamber, thereby enabling transfer of substrates from a cassette and transfer of substrates from and to the processing chamber by means of the robot, the robot becomes complex and large-scaled in the structure and the load-lock chamber volume also becomes large. Therefore, time is required for depressurizing the load-lock chamber to the pressure of the processing chamber. Furthermore, a large quantity of power is necessary for depressurizing the load-lock chamber.

The present inventors have already proposed a processing apparatus, for example, in Japanese Patent Application Laid-open No. Hei 10-30183 (1998), in which a transfer

robot is provided on the outside of the load-lock chamber, while the inside thereof is provided a handler unit for transferring substrates from the transfer robot and for transferring substrates from and to the processing chamber. Therefore, by making the structure of the handler unit simple, it is possible to obtain a small volume load-lock chamber.

In such a conventional processing apparatus, comprising the aforementioned load-lock chamber, a waiting chamber is provided below the processing chamber for generating plasma. The waiting chamber and the load-lock chamber communicate with each other through a shutter. Accordingly, for processing a substrate, the load-lock chamber, the processing chamber, and the waiting chamber have the same pressure, so as to conduct the following steps: transferring a substrate from the load-lock chamber to the waiting chamber, closing the shutter between the load-lock chamber and the waiting chamber, inserting the substrate from the waiting chamber to the processing chamber while reducing the pressure within the waiting chamber and the processing chamber, and generating plasma within the processing chamber, so as to conduct a predetermined treatment.

As was mentioned above, in a conventional processing method which uses the apparatus comprising the load-lock chamber, the waiting chamber and the processing chamber have the same pressure at the time of conducting an ashing treatment to the substrate in the processing chamber.

The processing chamber is, in many cases, made of synthetic quartz, but in general, the waiting chamber is made of aluminum alloy, having been treated with alumilite on the interior surfaces thereof.

Plasma is easy to generate in lower pressure. Therefore, in a case of the conventional processing method, since the waiting chamber is also in a depressurized condition during processing, residual gas remaining within the waiting chamber in a very small amount sometimes becomes plasma in consequence of the influence of applying high frequency power for generating plasma.

Once plasma is generated within the waiting chamber, plasma generated in the processing chamber becomes unstable due to the change in impedance. There is also a possibility of metal contamination occurring through peeling or flaking of the alumilite thin film due to the plasma, since the waiting chamber is made of aluminum alloy having been treated with alumilite on the interior surfaces thereof.

SUMMARY OF THE INVENTION

Therefore, for solving problems such as were mentioned above, the present invention provides a processing method which uses a processing apparatus in which a waiting chamber is provided below a processing chamber and a load-lock chamber is provided in addition to the waiting chamber, wherein pressure within the waiting chamber is kept high enough for no plasma to be generated therein, during which time a substrate is treated within the processing chamber, in which plasma is generated under a depressurized condition. The pressure in the waiting chamber is, specifically, preferred to be in a range of 200 Pa to 3000 Pa.

Because generation of plasma in the waiting chamber is controlled during processing of a substrate, plasma is stably generated in the processing chamber without change in impedance of the processing portion as a whole. Also, drawbacks of the waiting chamber can be solved, such as peeling of the alumilite thin film applied to the interior surfaces of the waiting chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of the entire apparatus for implementing the processing method according to the present invention;

Figure 2 is a first cross-sectional view of the apparatus of Figure 1 for explaining sequential steps in the same processing method;

Figure 3 is another cross-sectional view of the apparatus of Figure 1 for explaining the sequential steps in the same processing method; and

Figure 4 is still another cross-sectional view of the apparatus of Figure 1 for explaining the sequential steps in the same processing method.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereinafter, an embodiment according to the present invention will be fully explained by referring to the attached drawings.

In a processing apparatus, two processing portions are provided for one transfer robot 1, and each of the processing portions is comprised of a waiting chamber 2 made of aluminum alloy and a processing chamber 3 made of synthetic quartz provided on the waiting chamber 2. To the waiting chamber 2 is also provided a load-lock chamber 4.

Between the load-lock chamber 4 and the waiting chamber 2 is provided a shutter 5, and in the surface of the load-lock chamber 4 opposing the transfer robot 1 is provided a shutter 6 for shutting off from the outside. Further, a partition 7 is provided as a shut off between a pair of the load-lock chambers 4 and 4, and between a pair of the waiting chambers 2 and 2.

The transfer robot 1 mentioned above comprises an arm 10 on a rotatable table 8, the arm 10 being freely movable back and forth in the radial direction. At the tip of the arm 10 is provided a receiver portion 11 for a substrate W. Either the table 8 or the arm 10 can be lifted up and lowered. Although only the receiver portion 11 of the arm 10 is shown in the figure, it may be possible to provide two arms and to make each [being] independently controllable.

Within the load-lock chamber 4 is provided a handler unit 12 for transferring a substrate W into the inside of the processing chamber 2 and removing a substrate W from the inside of the processing chamber 2.

The handler unit 12 has a shaft 13, and the base end portions of two curved or bent arms 14 are attached to the upper and lower portions of the shaft 13 so as to freely rotatable in the horizontal surface. At the tip of the each arm 14 is provided a hand portion 15, and

a cutting portion 18 is formed in the radial direction from the central portion to the outer peripheral portion of the hand portion 15.

An exhaust pipe 20 and an introduction pipe 21 for N_2 or inert gas are connected to the waiting chamber 2. An exhaust pipe 30 and a reactive gas introduction pipe 31 from a mass-flow controller are connected to the processing chamber 3.

Further, a mounting table 22 is provided within the waiting chamber 2 mentioned above. The mounting table 22 can be lifted up and lowered by means of a cylinder unit 23, which is housed within a flexible tube 24, so that the cylinder unit 23 can be driven under a condition of being shut off from the inside of the waiting chamber 2. At the position when the mounting table 22 reaches the upper limit, a flange portion of the mounting table 22 air-tightly seals the lower end opening of the processing chamber 3.

An explanation will be given of the processing steps in the processing apparatus having the above-mentioned structure. However, the explanation will be made of only one of the processing portions. Also, the explanation will be started from a condition that an untreated substrate W is housed within the waiting chamber 2, an untreated substrate W is held by the hand portion 15 at the upper side of the load-lock chamber 4, the hand portion 15 at the lower side is vacant, and both of the shutters 5 and 6 are closed.

From the condition mentioned above, as is shown in Figure 2, the pressure within the waiting chamber 2 and the processing chamber 3 is reduced down to several Pa (Pascal) through the exhaust pipes 20 and 30. The mounting table 22 is lifted up, so that the untreated substrate W is in the processing chamber 3, and the mounting table 22 air-tightly seals the lower end opening of the processing chamber 3.

Next, nitrogen gas (or inert gas) is introduced into the waiting chamber 2 by using the pipe 21, thereby increasing the pressure within the waiting chamber 2 up to 200 - 3000 Pa. In parallel with this, gas for an ashing process is introduced from the mass-flow into the processing chamber 3. As a result, the pressure within the processing chamber 3 rises to around 100 Pa. Under this condition, as shown in Figure 3, high frequency power is applied to electrodes of the processing chamber 3, so as to generate plasma, thereby

conducting the ashing process on the substrate W.

After completing the process mentioned above, as shown in Figure 4, the pressure within the waiting chamber 2 is reduced through the pipe 20 until it is equal to the pressure within the processing chamber 3, and the mounting table 22 is then lowered. In this instance, the pressure within the load-lock chamber 4 is also reduced to be equal to that of the waiting chamber 2.

Next, the shutter 5 is opened, and the arm 14 at the lower side is rotated to enter the waiting chamber 2, thereby receiving the treated substrate W by the vacant hand 15. The arm 14 at the lower side returns into the load-lock chamber 4. Next, the arm 14 at the upper side is rotated to enter the waiting chamber 2, thereby transferring the untreated substrate W held on the hand 15 onto the mounting table 22. The arm 14 at the upper side returns into the load-lock chamber 4. This condition is shown in Figure 2.

Next, the above-mentioned processing will be conducted, and in parallel with this, the pressure in the load-lock chamber is made to return to atmospheric pressure and the treated substrate W is replaced by an untreated substrate W.

As was fully explained in the above, according to the present invention, for conducting an ashing process or the like to a substrate by using a processing apparatus, comprising a processing chamber and a waiting chamber provided below the processing chamber in which a load-lock chamber is provided to the waiting chamber, since the pressure within the waiting chamber is kept to be so high that no plasma is generated therein while a substrate is treated within the processing chamber maintained in a depressurized condition so as to generate plasma therein, no change occurs in impedance of the processing portion as a whole. As a result, plasma can be generated with stability in the processing chamber, and also a substrate can be protected from contamination because no peeling occurs on the inner surfaces thereof due to plasma.